LODGEPOLE PINE DWARFMISTLETOE SURVEY: ROOSEVELT AND MEDICINE BOW NATIONAL FORESTS

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Progress Report on 1953-54 Surveys

by

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INTRODUCTION

Although lodgepole pine dwarfmistletoe, Arceuthobium americanum Engelm., has been recognized as one of the important enemies of lodgepole pine for some time, little information is available on its abundance or the amount of damage caused by it. Le Barron (1947) lists dwarfmistletoe as the most important disease of lodgepole pine in the Northern Rocky Mountains and the Annual Report for 1953 for the Intermountain Forest and Range Experiment Station indicates that dwarfmistletoe is also the most important lodgepole pine disease in that region. General observations in the Central Rocky Mountains indicate that here too dwarfmistletoe is the most damaging disease agent. Mason (1915) indicated that dwarfmistletoe was often found on lodgepole in this region, although he thought that the serious damage occurred in scattered localized areas. Apparently his opinion was based primarily on observations in virgin stands and underestimated the importance of dwarfmistletoe, since it was not then appreciated how the parasite would intensify in cutover areas.

The most practical method of dwarfmistletoe control in lodgepole pine is clearcutting in blocks or strips which are large enough to minimize reinvasion by dwarfmistletoe from adjacent uncut stands during the reseeding period. To be effective the clearcutting must remove infected trees of all size classes. The recommended silvicultural practices for lodgepole pine stands in Montana (Le Barron - 1952) indicate that the most desirable stand improvement measure is the destruction of cull trees left in lodgepole pine clearcuttings. Studies are being conducted in Colorado and Wyoming to determine the extent of dwarfmistletoe invasion into the regeneration on clear-cut areas from adjacent, uncut infected stands during the reseeding period.

In view of the increased utilization of lodgepole pine and observations on the widespread occurrence of dwarfmistletoe in the Central Rocky Mountains, it was thought that a survey to determine the importance of dwarfmistletoe in the region was in order. The plans for the survey were drawn up in cooperation with the Division of Timber Management of the Region 2 office in Denver.

PURPOSE

The objectives of the survey were:

(1) To determine the abundance of dwarfmistletoe in virgin, cutover, and pole stands.

(2) To determine the extent of damage caused by dwarfmistletoe in merchantable and submerchantable lodgepole pine.

ACKNOWLEDGMENTS

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METHODS

The plan of the survey was twofold:

Roadside Survey

This part of the survey was designed to yield information on the abundance of dwarfmistletoe. A motor vehicle with a 2-man crew was used for the roadside survey. All passable roads through the lodgepole pine type were traversed and the roadside conditions of the following factors noted:

(1) Occurrence of dwarfmistletoe: Light, moderate, or heavy

(2) Stand condition: Virgin, cutover, or regenerated burns

(3) Type of stand: Mature, large poles, small poles, or saplings

The roadside survey, of course, left vast inaccessible areas unsampled, especially in the Roosevelt National Forest; however, the stands which were covered are those of most immediate concern to management.

Sample Strips

Sample strips with eight 1/10-acre plots per linear mile were run through representative stands to provide information on mortality, percentage of merchantable trees infected, per-acre volumes, and amount of infection in pole-sized trees.

Details on the methods and copies of the field forms used are given in the appendix.

RESULTS

About 10 weeks were spent on the field work on the survey: 8 weeks during the summer of 1953 and 2 weeks in 1954.

Abundance of Dwarfmistletoe in Lodgepole Pine Stands

A total of 536.80 miles of roadside strip through commercial lodgepole pine stands was run and dwarfmistletoe was found along 304.95 miles or in 57 percent of the stands examined. The results by ranger districts in each forest are given in Table 1. The proportion of all stands infected was 52 percent on the Roosevelt National Forest and 59 percent on the Medicine Bow.

Table 1.--Summary of Roadside Survey by Ranger Districts

Administrative Unit	Miles Traveled Through Commercial Lodgepole Pine Type		
	Total	Dwarfmistletoe-infected stands	
	(number)	(number)	(percent)
Roosevelt National Forest			
Poudre District	23.40	10.80	46
Redfeather District	74.20	35.30	48
Laramie River District	72.05	42.75	59
Total	169.65	88.85	52
Medicine Bow National Forest			
Centennial District	36.15	16.90	47
Foxpark District	151.70	96.95	64
Keystone District	82.80	42.30	51
Brush Creek District	62.40	42.45	68
Encampment District	34.10	17.50	51
Total	367.15	216.10	59
Roosevelt and Medicine Bow Combined	536.80	304.95	57

In addition to the commonly observed intensification of dwarfmistletoe on infected trees left in cutover areas the survey data suggest that the opening up of stands by cutting has brought about an increase in area infected by dwarfmistletoe (Table 2). Preliminary studies on the rate of spread of lodgepole pine dwarfmistletoe indicate that it progresses twice as rapidly through open stands (those in which the canopy had not closed) as through dense stands and hence selective cutting would be expected to increase the rate of spread of this parasite.

Table 2.--Summary of Dwarfmistletoe Infection in the Roadside Strips in Various Types of Stands (Both Forests Combined)

Type of Stand	Miles of roadside strip	Proportion of Lodgepole Pine Type				
		Dwarfmistletoe infected				Dwarf-mistletoe free
		Light	Moderate	Heavy	Total	
	(number)	(percent)	(percent)	(percent)	(percent)	(percent)
Virgin	119.60	12	12	30	54	46
Cutover	297.85	15	12	42	69	31
Regenerated burns	119.35	11	11	6	28	72
Totals	536.80	13	12	32	57	43

As is shown in Table 2, dwarfmistletoe is considerably more abundant in cutover areas (69 percent) than in virgin stands (54 percent). The fact that dwarfmistletoe was consistently more abundant in cutover than in virgin stands on all ranger districts surveyed strongly suggests that these differences are due to increased dwarfmistletoe activity in cutover areas and not merely due to the location of currently infected virgin and cutover stands.

Pole stands on regenerated burns were relatively free from infection (28 percent). This is to be expected because of their lower age and consequent shorter time they have been subject to dwarfmistletoe attack. Essentially all of the pole stands observed were in regenerated burns; in the majority of cases no overstory trees survived the fires, and therefore the infection chain in these areas was broken. Practically all dwarfmistletoe infection in pole stands in regenerated burns can be traced to nearby overstory trees or groups which survived the burn. From Table 2 it is seen that the proportion of heavily infected pole stands in regenerated burns is about one-fourth that of the combined stands of light and moderate infection, while in both virgin and cutover stands the percentage of heavily infected stands exceeds the combined totals of lightly and moderately infected areas.

Data on distribution of dwarfmistletoe on various sites are available from the sample strips, which show that lodgepole pine dwarfmistletoe is proportionately more abundant on ridge sites than on bottom sites (Table 3); dwarfmistletoe on ponderosa pine in the Southwest exhibits a similar relationship.

Table 3.--Relationship Between Incidence of Lodgepole Pine Dwarfmistletoe and Slope Position

Slope Position	Plots in commercial lodgepole pine type		Plots with dwarfmistletoe	
	(number)	(percent)	(number)	(percent)
Bottom	8	3	4	50
Slope	262	89	194	74
Ridge	23	8	20	87
Total	293	100	218	74

Since the strips were run in areas where dwarfmistletoe was a problem, the percentage of plots with dwarfmistletoe was higher (74 percent) than the percentage of area infected as determined by the roadside survey (57 percent). The distribution of the plot sample is given in the appendix.

Dwarfmistletoe in Merchantable Stands

The living merchantable gross volume per acre (Table 4) in dwarfmistletoe-free virgin stands (10,950 board feet) was nearly 1½ times that in virgin stands where dwarfmistletoe was present (7,590 board feet). A tabulation of slope type plots only showed a similar relationship: 11,190 board feet per acre, gross volume, in dwarfmistletoe-free stands and 7,480 board feet per acre, gross volume, in virgin stands with dwarfmistletoe.

Table 4.--Dwarfmistletoe Infections and Mortality in Merchantable Lodgepole Pine Stands--Combined Data from the Roosevelt and Medicine Bow National Forests

Stand Condition	Plot Basis	Gross Volume Per acre			Mortality dead vol. / Total vol.
		Living	Dead	Total	
	(no.)	(bd.ft.)	(bd.ft.)	(bd.ft.)	(percent)
Virgin					
Dwarfmistletoe-infected stands	88	7,590	1,010	8,600	12
Dwarfmistletoe-free stands	31	10,950	810	11,760	7
Difference*	-	-3,360	+ 200	-3,160	+ 5
Cutover					
Dwarfmistletoe-infected stands	109	3,500	320	3,820	8
Dwarfmistletoe-free stands	23	3,670	70	3,740	2
Difference*	-	- 170	+ 250	+ 80	+ 6
Virgin and Cutover Combined					
Dwarfmistletoe-infected stands	197	5,330	630	5,960	11
Dwarfmistletoe-free stands	54	7,850	490	8,340	6
Difference*	-	-2,520	+ 140	-2,380	+ 5

*Dwarfmistletoe-infected stands as compared with dwarfmistletoe-free.

Mortality for this report was calculated as the dead standing trees with bark intact as a percentage of the total stand (living plus dead). The mortality rate in infected virgin stands (12 percent) was 1.7 times that in the dwarfmistletoe-free virgin stands (7 percent), while the mortality rate in infected cutover stands (8 percent) was 4 times that in dwarfmistletoe-free cutover areas (2 percent). Percent mortality in all stands (dwarfmistletoe-infected and dwarfmistletoe-free) was 9 percent; 10 percent in virgin stands and 7 percent in cutover areas. Dwarfmistletoe was found in 70 percent of the dead merchantable trees on the plots; these trees also accounted for 70 percent of the dead volume. As is shown in Table 5, a high proportion, 65 percent, of the dwarfmistletoe-infected trees are in the poorer vigor classes (Taylor's classes C and D), as compared with 45 percent for dwarfmistletoe-free trees. It should be emphasized that this is the result of prolonged dwarfmistletoe infection and not due to preferential attack of trees of poorer vigor. Dwarfmistletoes are known to make their best initial development on trees of good vigor.

Table 5.--Vigor Classes of Merchantable Lodgepole Pine in Relation to Stand Condition and Presence of Dwarfmistletoe (Basis: 1,804 trees)

Stand Condition	Taylor's Vigor Class (1939-Literature Cited)	Dwarfmistletoe-infected Volume in Trees of Each Vigor Class (percent)	Dwarfmistletoe-free Volume in Trees of Each Vigor Class (percent)
Virgin	A	5) -32	8) -54
	B	27)	46)
	C	41) -68	30) -46
	D	27)	16)
Cutover	A	12) -42	25) -59
	B	30)	34)
	C	33) -58	30) -41
	D	25)	11)
Virgin and Cutover Combined	A	7) -35	13) -55
	B	28)	42)
	C	38) -65	31) -45
	D	27)	14)

Dwarfmistletoe in Unmerchantable-size Classes

The pole stand on the plots averaged 442 living poles per acre (Table 6); 92 large and 350 small.

Table 6.--Pole Stand Per Acre in Dwarfmistletoe-infected and Dwarfmistletoe-free Areas (Basis: All 293 Plots)

Degree of Dwarfmistletoe	Number stems per acre		
	Large poles	Small poles	All poles
Dwarfmistletoe-infected plots	76	314	390
Dwarfmistletoe-free plots	123	453	576
All plots combined	92	350	442

The stands in dwarfmistletoe-free areas averaged about 1½ times as many poles per acre as in infected stands. Mortality in large poles was directly associated with presence of dwarfmistletoe, but this was not the case for small poles (Table 7).

Table 7.--The Relationship Between Dwarfmistletoe and Mortality in Pole Classes

Type of stand	Plot basis	Mortality*					
		Large poles		Small poles		All poles	
		Dwarfmistletoe-infected plots	Dwarfmistletoe-free plots	Dwarfmistletoe-infected plots	Dwarfmistletoe-free plots	Dwarfmistletoe-infected plots	Dwarfmistletoe-free plots
	(No.)	(percent)	(percent)	(percent)	(percent)	(percent)	(percent)
Virgin	119	24	9	13	9	18	9
Cutover	132	10	8	7	5	7	5
Regenerated burns	42	4	1	12	13	11	13
Total--All stands	293	16	5	9	11	10	10

*Dead standing trees as percent of living plus dead stems.

Suppression was an important mortality factor in the small pole-size class. Since pole stands are considerably more dense in dwarfmistletoe-free areas, the number of trees dying out because of suppression would be expected to be greater than in the more open (dwarfmistletoe-infected) stands.

Percent mortality in large poles was heaviest in virgin stands, lighter in cutover areas, and lightest in pole stands (Table 7). These differences are probably related to the length of time during which dwarfmistletoe infection has been present in the three types of stands.

DISCUSSION

The survey data bring out the importance of dwarfmistletoe in cutover lodgepole pine stands, as mortality in cutover dwarfmistletoe-infected stands is four times as high as that in dwarfmistletoe-free cutover stands. Practically all cutover stands examined on these forests have been selectively logged--even in so-called "clear-cut" areas only merchantable stems have been removed.

Figure 1 shows a stand typical of thousands of acres of national forest cutover stands. This particular stand was cut about 10 years ago; many unmerchantable stems and a few merchantable-sized trees were left. The heavily dwarfmistletoe-infected trees left have passed or will pass the infection on to the trees of the young stand. Figure 2 shows a stand which, while still not ideal, illustrates a much more desirable condition than the stand in Figure 1. Here cutting was more severe and most of the remaining trees, although heavily infected, are dead or will die before they can bring about a serious amount of infection of the young stand. However, a dwarfmistletoe-free young stand could be assured by the expenditure of a small amount of additional labor in felling the remaining lodgepole pines left after cutting operations. The lodgepole pine dwarfmistletoe does not attack the tree species commonly associated with lodgepole pine (Engelmann spruce and alpine fir), so there is no danger of these species carrying on the infection and reinfecting the lodgepole pine reproduction. In older cutover areas where the remaining overstory trees have already reinfected the young stand the dwarfmistletoe control program is considerably more difficult. Here, studies are needed to ascertain the values of the timber and the production potential in dwarfmistletoe-infected, selectively-logged stands in order to determine the extent to which investments in dwarfmistletoe control on such areas may be justified.

SUMMARY

In order to determine the abundance of lodgepole pine dwarfmistletoe, roadside surveys were run on three ranger districts of the Roosevelt and on five districts of the Medicine Bow National Forests. A total of 536.8 miles through the lodgepole pine type was run and dwarfmistletoe was found in 57 percent of the stands: 52 percent on the Roosevelt and 59 percent on the Medicine Bow. Dwarfmistletoe was found in 69 percent of the cutover stands, in 54 percent of the virgin stands, and in 28 percent of the pole stands.

In addition to the roadside survey, sample strips with randomized plots were run to provide more detailed information on infected and dwarfmistletoe-free stands. A total of 293 1/10-acre plots was established in the lodgepole pine type. A direct relationship between slope position and incidence of lodgepole pine dwarfmistletoe was found to exist. Percentage infection figures for the different sites were: Bottom - 50; Slope - 74; and Ridge - 87. Slope sites constituted 89 percent of the total area.

Dwarfmistletoe-free virgin stands had nearly 1½ times the living volume of dwarfmistletoe-infected stands. The mortality rate in virgin stands with dwarfmistletoe was 1.7 times that in the dwarfmistletoe-free virgin stands, while the mortality rate in infected cutover stands was four times that in cutover stands in dwarfmistletoe-free areas.

Dwarfmistletoe was found in 70 percent of the dead merchantable-sized lodgepole pine on the plots. Only 35 percent of the dwarfmistletoe-infected trees were in the better vigor classes (Taylor's vigor classes A and B), while the comparable figure for dwarfmistletoe-free trees was 55 percent.

The pole stand on the plots averaged about 440 poles per acre. Stands in dwarfmistletoe-free areas averaged 1½ times as many poles per acre as infected stands. Mortality in large poles was directly associated with the presence of dwarfmistletoe; but this was not true for trees in the small pole-size class, where suppression is a more important mortality factor.

LITERATURE CITED

Le Barron, R. K. Cutting Lodgepole Pine in the Northern Rocky Mountains. Proc. Soc. American Foresters Meeting, pp. 399-403. 1947.

_____ Silvicultural Practices for Lodgepole Pine in Montana. Northern Rocky Mountain Forest and Range Experiment Station. Station Paper No. 33, 19 pp. 1952.

Mason, D. T. The Life History of Lodgepole Pine in the Rocky Mountains. USDA Bull. 154, pp. 1-35. 1915.

Taylor, R. F. The Application of a Tree Classification in Marking Lodgepole Pine for Selection Cutting. Jour. Forestry 37(10): 777-782. 1939.

Figure 1.--Heavily dwarfmistletoe-infected lodgepole pine stand about 10 years after cutting. Only merchantable-sized trees were cut. Subsequent mortality in residual trees has been high but a number of dwarfmistletoe-infected residual trees have survived and seriously reinfected the young stand. Bull Mountain, Roosevelt National Forest, Colorado. 1953.

Figure 2.--Heavily dwarfmistletoe-infected lodgepole pine stand 2 years after cutting. The clearcutting in this area has been much more complete than that in the stand shown in Figure 1. Most of the residual trees are dead or will die within a few years. A mistletoe-free young stand could be assured by felling all remaining infected trees before the reproduction is established. Pingham Creek, Roosevelt National Forest, Colorado.

APPENDIX

SURVEY METHODS

Roadside Survey

All passable roads through the lodgepole pine type were traversed slowly (less than 10 m.p.h.) and the roadside conditions along one side recorded on the attached form. The sample strip width was taken as one chain in virgin and cutover stands and as one-half chain for pole stands. Speedometer readings were taken whenever changes in the stands or degree of infection were noted and distances recorded to the nearest one-twentieth of a mile.

Size class:	Merchantable:	Trees over 9.6" d.b.h.
	Large poles:	Trees 5.6" to 9.5" d.b.h.
	Small poles:	Trees 6' high to 5.5" d.b.h.
	Saplings:	Trees under 6' high
Dwarfmistletoe:	Light:	Less than one-third of trees in predominant size class infected
	Moderate:	1/3 to 2/3 of trees in predominant size class infected
	Heavy:	Over two-thirds of trees in predominant size class infected

The only other column used was the one headed "Remarks" where the stand condition was noted as:

Virgin	
Cutover:	Clear-cut
	Selection
Poles:	Thinned
	Natural

Sample Strips

Sample strips with eight 1/10-acre circular plots per mile were run in selected areas. The areas chosen were thought to be problem areas representative of the ranger district. The locations of the starting points for the strips were determined mechanically and without reference to presence or absence of dwarfmistletoe. At each study locality 2 miles or more of strip were run. The strips were run in one of the eight major compass points with primary emphasis on obtaining cross sections of drainages. The locations of the plots along the line were predetermined by use of a table of random numbers. The distance between strips was randomized but was not less than 1/4- nor more than 1/2-mile. The method of record taking on the plot was as follows:

National Forest _____ District _____ Date _____ Sheet _____

Land Class and Acres	Strip: H	Size: LP	Size: SP	Size: Sap.	Mistletoe: L	Mistletoe: M	Mistletoe: H	St.	PP	DF	QA	None	Remarks
		Lodgepole Pine											

Township, Range, and Section	were determined approximately from the forest maps.
Strip:	Number of strip in the district
Line:	Direction of strip
Plot No.:	Distance in chains of the plot from the starting point
Site:	Location of plot as to bottom, slope, or ridge
Elevation:	Aneroid determination to nearest 50 feet
Forest type:	Not used, as only plots in the lodgepole pine type were recorded
Aspect:	One of the eight major aspects
Slope:	L = Level: Less than 5 percent G = Gentle: 5 to 10 percent M = Moderate: 10 to 30 percent S = Steep: Over 30 percent
Remarks:	General notes, including estimates of time since logging.
Merchantable:	For each lodgepole pine 9.6 inches d.b.h. or over the diameter class, 8-ft. log height, vigor class, and degree of dwarfmistletoe were recorded.
D.b.h.	One inch diameter classes: 9.6-10.5, 10.6-11.5, 11.6-12.5, etc.
"Species and Risk":	Taylor's four vigor classes were used.
Infection:	Each infected tree was given one of six degrees of dwarfmistletoe infection determined by classifying each one-third of the crown as either 1 (light dwarfmistletoe) or 2 (heavy dwarfmistletoe) and adding the 3 figures, e.g., 6 = entire tree heavy.
Dead:	Only dead standing trees with bark intact were recorded and presence or absence of dwarfmistletoe signs noted.
Other species:	ES for Engelmann spruce and AF for alpine fir
Poles:	Large poles: Trees 5.6" to 9.5" d.b.h. Small poles: Trees 6' high to 5.5" d.b.h.
Prunable:	This column was not used as it is not considered feasible to prune out dwarfmistletoe-infected branches in lodgepole pine.

LODGEPOLE PINE DWARF MISTLETOE SURVEY PLOT RECORD

Nat'l. Forest _____ District _____ T. _____ R. _____ Sec. _____

Strip _____ Line _____ Plot No. _____ Site _____ Elevation _____ Forest Type _____

Aspect _____ Slope _____ Date _____ Party _____ Remarks: _____

MERCHANTABLE

D.B.H.	Species and risk	Infection 1	2	3	4	5	6	Total	No mist.	Total living	Dead with mist.	Dead No mist.	Dead Total	Other sp. ES	Other sp. AF
10	LPP:														
11	LPP:														
12	LPP:														
13	LPP:														
	LPP:														
	LPP:														
	LPP:														
	LPP:														
	LPP:														
Total	LPP: A														
	B														
	C														
	D														

	Infection Prunable	Infection Not prunable	Infection Total	No mistletoe	Total living	Dead	C. Hark.	Other Species ES	Other Species AF
Large poles									
Small poles									
Saplings									

The following table shows the distribution of the 293 1/10-acre sample plots in the two national forests:

Stand Condition	Roosevelt N.F.			Medicine Bow N.F.			Both Forests		
	With dwarf-mistle-toe	Dwarf-mistle-toe-free	Totals	With dwarf-mistle-toe	Dwarf-mistle-toe-free	Totals	With dwarf-mistle-toe	Dwarf-mistle-toe-free	Totals
Virgin	60	29	89	28	2	30	88	31	119
Cutover	41	9	50	68	14	82	109	23	132
Regenerated burns	6	4	10	15	17	32	21	21	42
Totals	107	42	149	111	33	144	218	75	293